Review of "Computational logic and human thinking: How to be artificially intelligent" by Robert Kowalski

Review of "Computational Logic and Human Thinking: How to be Artificially Intelligent" by Robert Kowalski

Alan Bundy
School of Informatics, University of Edinburgh,
Informatics Forum, 10 Crichton St,
Edinburgh, EH8 9AB, Scotland

1 August 2012

Abstract

This is a review of the book "Computational Logic and Human Thinking: How to be Artificially Intelligent" by Robert Kowalski.

Keywords: computational logic, human thinking, book review.

Any book containing a chapter entitled "The meaning of life" will certainly catch your attention. That's the Good News. The Bad News is that the life in question is that of a wood louse.

We've waited nearly three decades for a sequel to Bob Kowalski's seminal "Logic for Problem Solving", which became the bible of the logic programming community. In "Computational Logic and Human Thinking", Kowalski finally ends that wait with a book ostensibly aimed, not at the computing community, but at the lay public. His declared aim is to assist people to improve their own thinking by understanding the processes of reasoning. In particular, Kowalski shows how computational logic can be applied to a wide diversity of reasoning tasks. The first 17 chapters each consider a different type of reasoning. Starting with deductive reasoning on horn clauses, Kowalski considers abduction, induction, planning, temporal, non-monotonicity, decision making, meta-reasoning and many other forms of reasoning, showing how computational logic can be extended to encompass and explain them all.

For this lay audience, it is vital that the explanations are as accessible as possible, avoiding technicalities and formulae. He has taken great pains to achieve this: formulae are rendered into English sentences; reasoning processes are illustrated with copious familiar examples; and the prose is kept as simple as possible. A host of characters become our friends: from a hungry and cunning fox trying to steal cheese from a gullible crow to the aforementioned wood louse, via a mars rover, someone contemplating becoming a British citizen, another deciding whether to sound the alarm in a train and many more. Just occasionally a technical term creeps in unannounced, but a full technical explanation is available, for those who want to delve deeper, in 6 comprehensive appendices.

As well as this declared aim of public understanding and self-improvement, however, there are two other undeclared aims of the book. It also serves both as a summary of Kowalski's research programme since his foundation of logic programming and as a vehicle to show how most areas of AI can shelter under the computational logic umbrella.

By *computational logic*, Kowalski means resolution applied to first-order horn clauses. He argues that this a strong candidate for a *language of thought*, self-knowledge of which can improve human reasoning. His illustrations of human and animal reasoning soon show the need for non-deductive reasoning, such as abduction, induction and negation as failure, and he shows how computational logic can be extended to encompass them. His preferred resolution calculus is his

connection graphs, which manipulate networks of clauses connected by unification links between literals. He draws an analogy with neural nets and suggests that probablistic reasoning can be smuggled in via weights. Frustratingly, these two potential extensions of computational logic are not fully developed. What he does discuss in detail is his work on the event calculus, game-theoretic decision making, meta-level reasoning and the semantics of logic programming.

To argue for the psychological validity of this extended computational logic, Kowalski must see off the opposition. He, therefore, devotes a whole chapter to show how Wason's selection task, usually seen as evidence of the non-logical nature of human reasoning, can be encompassed within his framework. He also argues that production rules can be seen as a limited sub-calculus of computational logic. He can't resist a tilt at object-oriented programming, identifying a 'moderate' form of it that can also be seen as a variant of computational logic.

"Computational Logic and Human Thinking" might make an excellent basis for a course on AI for non-science students. It covers a wide range of AI techniques in an accessible form and within a uniform framework, with more technical details available as optional extensions. Moreover, Kowalski's enthusiasm for and dedication to his subject shines through on every page.